



Transmittal Note

Manual on the Use of the Collision Risk Model (CRM)  
for ILS Operations (Doc 9274-AN/904)

Amendment No. 2

1. Insert the following replacement pages to incorporate Amendment No. 2.

*Note: When replacing Examples and Reports retain all dividers in place.*

Foreword	Page (vi).
Appendix B	Pages I-B-1, I-B-2, I-B-5, I-B-9
Appendix D	Pages I-D-2, I-D-3, I-D-6, I-D-10, I-D-12, I-D-13, I-D-16, I-D-20, I-D-24, I-D-25, I-D-29, I-D-32a, I-D-35, I-D-36, I-D-39, I-D-46, I-D-48, I-D-49, I-D-52, I-D-54, I-D-55, I-D-56.
PART II	Pages II-6-3, II-6-8.

2. Record entry of this amendment on page (ii).



# Foreword

## General

The purpose of this document is to present a comprehensive description of the Collision Risk Model (CRM) and instructions for its use.

The Collision Risk Model is a computer programme that calculates the probability of collision with obstacles by an aeroplane on an ILS approach and possible subsequent missed approach. The CRM was developed by the Obstacle Clearance Panel as a result of an extensive data collection programme followed by detailed mathematical analysis. The CRM is an important part of the criteria for ILS operations described in Part III of the PANS-OPS, Volume II (Doc 8168-OPS/611) (Reference 1) which acts as a working document for the procedures specialist in the design and construction of visual and instrument approach procedures. The operational use of these procedures is described in PANS-OPS, Volume I (Reference 2) for the guidance of flight operations personnel.

During its work the Obstacle Clearance Panel developed a system of surfaces, referred to as the obstacle assessment surfaces (OAS) (Reference 1). The OAS surfaces enable the obstacles in the vicinity of a runway to be partitioned into those "accountable" obstacles which penetrate the surfaces and those "non-accountable" obstacles which do not penetrate. An obstacle clearance altitude/height (OCA/H) is then chosen to ensure that the path of an aeroplane flying an ILS approach and missed approach will remain safely above all accountable obstacles. This method, while simple in concept and easy to apply in practice, suffers from two main drawbacks.

Firstly, the requirements that the OAS be of simple form (a set of plane surfaces) to allow easy manual application of the criteria results in the surfaces being over-protective in certain areas. The method of construction of the OAS means that this is particularly the case in the vicinity of the runway. This is precisely the area where critical obstacles (glide path antenna, holding aircraft, etc.) are most likely to be sited. Hence, under the OAS criteria such obstacles may unnecessarily prevent aeroplanes operating to low minima.

Secondly, the use of the OAS implies that these surfaces could become solid walls without any operational penalty in terms of an increase in OCA/H. Clearly such a situation would seriously degrade safety. If left entirely to the operational judgement of the procedures specialist to decide at what point there exists an excessive density of obstacles around the runway, an insufficient operational penalty could result.

Therefore, although the OAS criteria are designed to achieve a specified target level of safety, they may result in a greater level of safety being imposed and consequently unnecessarily prevent operations to low minima or, alternatively, they may result in the safety of operations being degraded below the required standards. The CRM has been developed in response to these problems.

The CRM is designed to:

- a) provide risk computations (separately for all obstacles and for individual obstacles) to a specific set of conditions and runway environment; and
- b) provide minimum acceptable OCA or OCH values for a specific set of conditions and runway environment.

The CRM may also be used to assist:

- in aerodrome planning (in evaluating possible locations for new runways in a given geographical and obstacle environment);
- in deciding whether or not an existing object should be removed; and
- in deciding whether or not a particular new construction would result in operational penalty (i.e., in an increase in the OCA/H).

## Presentation

The material in this manual is divided into three parts as follows:

### *Part I — Instructions on the Use of the CRM*

Explains the details related to the use of the CRM including various options. Related forms and samples are attached. Familiarization with this part is necessary prior to use of the ICAO CRM service.

***Part II – Background and Derivation of the CRM***

Explains the philosophy of the CRM and the mathematical and/or statistical assumptions made in its derivation. Familiarization with this part is not necessary prior to using the ICAO CRM service but will help in the understanding of the application of the CRM and in the interpretation of the CRM output information.

***Part III – Implementation of the CRM Computer Programmes***

Details related to the acquisition of the CRM computer programme are explained in this part. It also contains information relevant to the implementation and use of such programmes outside ICAO. This part also gives a description of the organization of the CRM computer programmes and the required data files.

**Applicability**

The material in this manual is free of mandatory implications. However, with a view to promoting world-wide uniformity in the application of the CRM, States are urged to use, to the extent possible, the material and procedures provided in this manual. It is important that the output information from the CRM implemented on a user's computer be exactly the same as that from the ICAO computer. If for some reason it is necessary to alter the CRM programme implemented on a user's computer from that in the ICAO computer the resulting information should not be referred to as CRM information.

**Amendment No. 1**

Amendment No. 1 has been developed in response to a recommendation made by the Obstacle Clearance Panel at

its seventh meeting (Montreal, 23 February – 13 March 1981). In addition to some editorial changes to the manual the amendment includes the following system enhancements:

- 1) the capability to process multiple requested cases in a single computer run;
- 2) the capability of defining obstacles by "wall" models in all input data coordinate systems, and
- 3) the capability of providing a warning when the Annex 14 inner approach, inner transitional and balked landing surfaces based on a horizontal runway are penetrated.

The amendment also makes reference to a new document *Software Documentation for the Collision Risk Model (CRM) for ILS Operations* (Doc 9387-AN/917) which has been developed by ICAO as a result of a request of the above-mentioned panel meeting. This document, intended for use by computer specialists, is not part of the amendment but can be obtained from ICAO in English, upon request.

**Amendment No. 2**

Amendment No. 2 contains editorial modifications to the Collision Risk Model Request Form and the descriptive text.

**Updating of the Manual**

It is intended that the manual be kept up to date. Future editions will be improved on the basis of the results of the work of ICAO and of comments and suggestions received from the users of this manual. Therefore, readers are invited to give their views, comments and suggestions on this edition. These should be directed to the Secretary General of ICAO. However, it should be noted that the actual programme of risk calculation will be amended only if it becomes necessary to change the basic criteria contained in PANS-OPS, Volume II.



# COLLISION RISK MODEL REQUEST FORM

(Revision 2)

Page 1

## Appendix B

### Sample CRM Request Form

Boxes which must be filled in to operate the model are shaded thusly:

**GROUND DATA**

- 07** ILS glide path angle      4      .      4      degrees
- 08** ILS reference datum height      4      .      7      M/F
- 09** Distance between ILS localizer antenna and runway threshold      4      .      9      M/F
- 10** Localizer course width at threshold      4      .      7      M/F
- 11** Threshold elevation      4      .      9      M/F
- 12** Distance from final approach point to threshold      4      .      9      M/F
- 13** Standard termination of precision segment  
If No then:  
a) Termination point before threshold  
b) Specify distance from termination point to threshold      4      .      6      Y/N
- 14** Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna  
b) Wing semispan      6      .      11      15      M/F
- 15** Standard missed approach climb gradient  
If No then specify climb gradient      6      .      4      Y/N      per cent

**AEROPLANE DATA**


---

M = Metres, F = Feet, Y = Yes, N = No

**25**  Polar coordinate system used  
If Yes then specify.

a) Unit of distance measurement

M/F

b) Unit of vertical measurement

M/F

c) Bearing to threshold

degrees

d) Distance to threshold

10                     .    

16                     .    

24                     .    

30                     .    

36                     .    

e) Height of threshold measured from this system reference

degrees

f) Bearing to LLZ antenna

degrees

g) Distance to LLZ antenna

**26**  Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

M/F

b) Latitude of threshold

degrees

8                     .    

10                     .    

13                     .    

16                     .    

seconds

c) Longitude of threshold

degrees

21                     .    

23                     .    

27                     .    

30                     .    

35                     .    

seconds

d) Height of threshold measured from this system reference

degrees

41                     .    

43                     .    

46                     .    

49                     .    

seconds

e) Latitude of LLZ antenna

degrees

54                     .    

56                     .    

60                     .    

63                     .    

seconds

f) Longitude of LLZ antenna

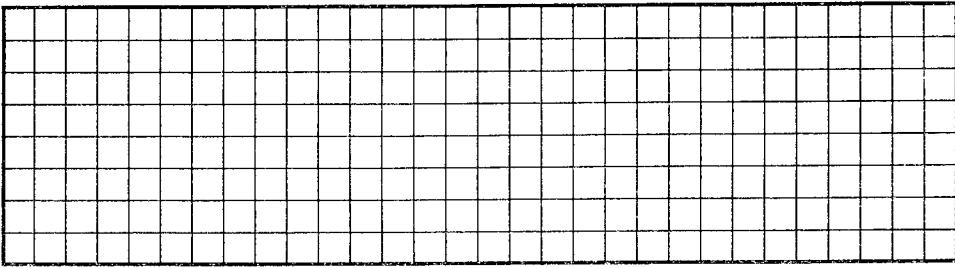
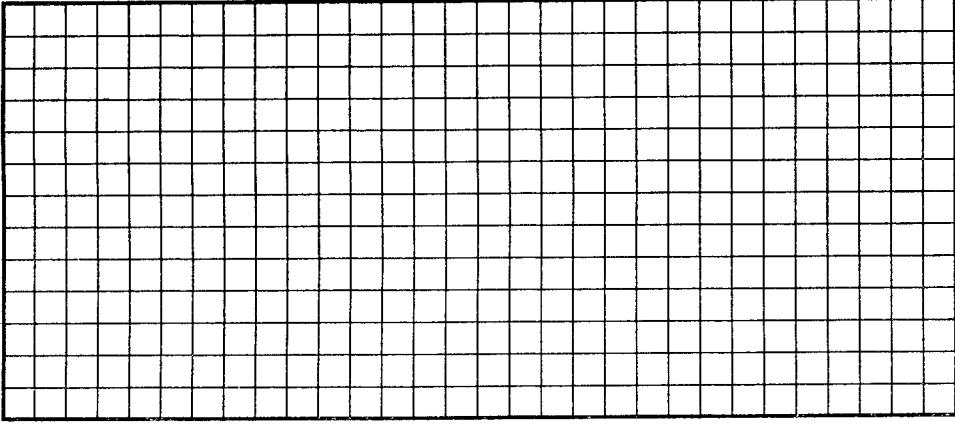
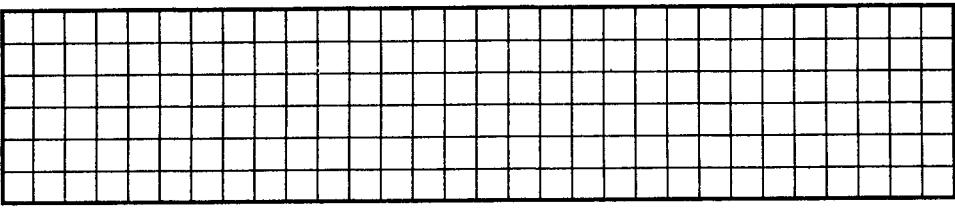
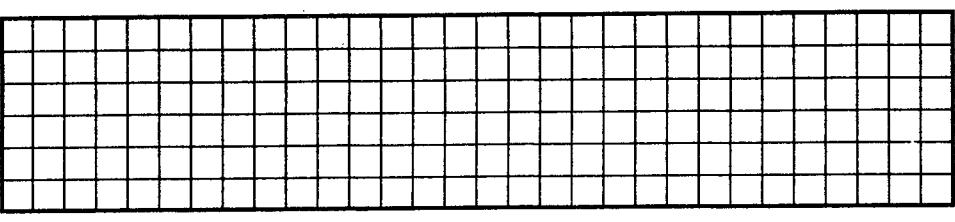
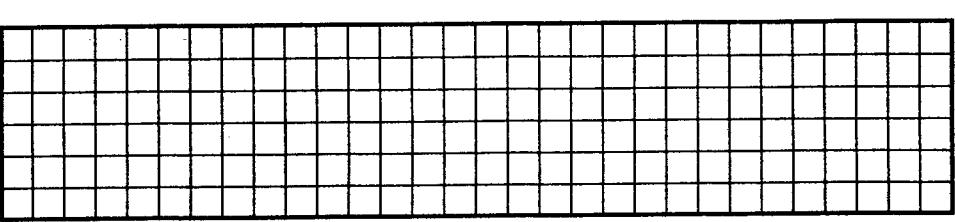
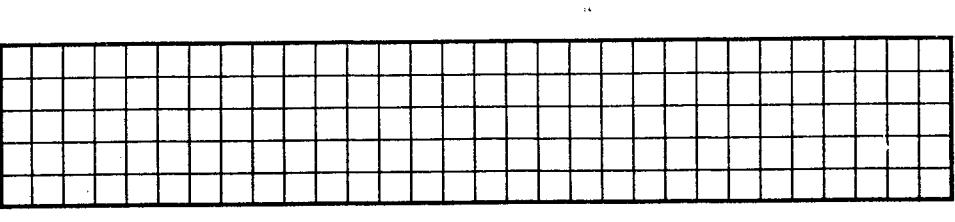
N = North, S = South, E = East, W = West

Page 6 of   **OBSTACLE DATA FILE**

[27] Runway coordinate system

IDENT

DESCRIPTION

4	
13	
31	
43	
50	
57	

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9  
of  
Page

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.

3



## EXAMPLE 1 CAT II RUNWAY — OCH VALUES LESS THAN 30 M

### Introduction

In this example an approach to a precision approach runway serviced by CAT II ILS is examined. The runway threshold is at the mean sea level (MSL).

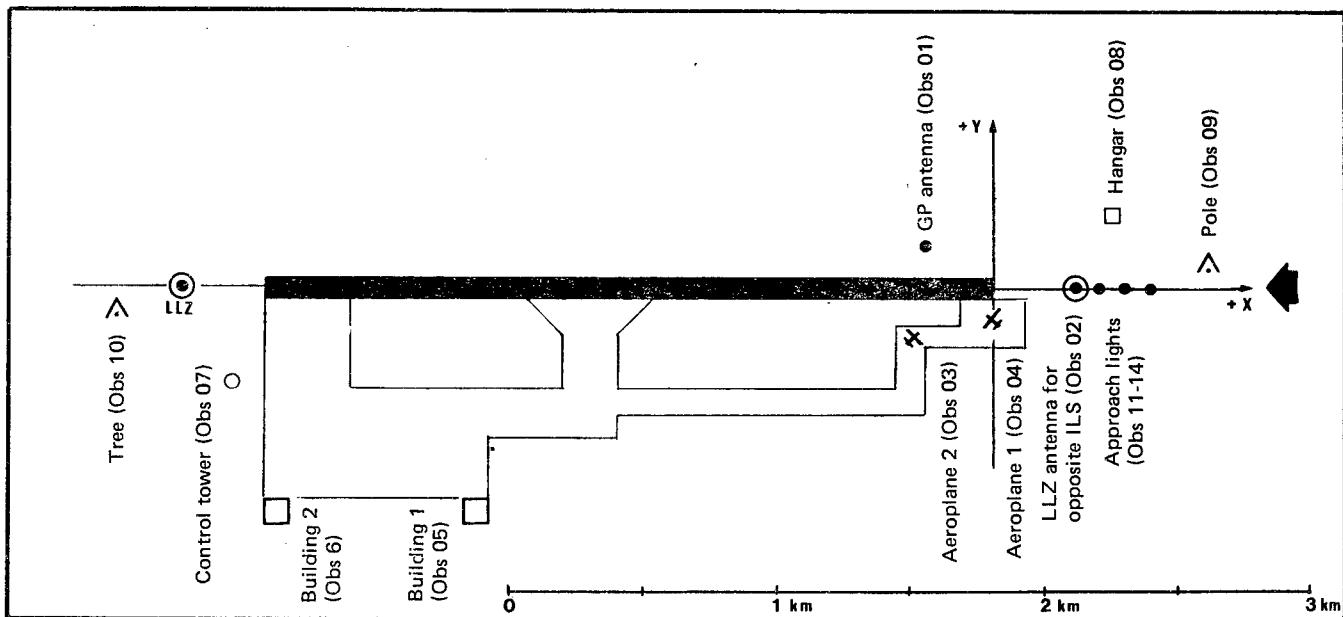
The ILS ground equipment is so installed that the ILS reference datum height and the localizer course width at threshold are standard and that the glide path angle is 3.00°. Distance between the ILS localizer antenna and the threshold is 3 000 m and the final approach point (FAP) is 10 807 m before the threshold and no obstacles are situated beyond this point.

The procedure is to be designed for aeroplanes up to standard dimensions, equipped with a flight director and being able to obtain at least the standard missed approach climb gradient.

The obstacle environment consists of 14 obstacles, specified in the CRM Request Form (see Item 27). A representation of the layout together with the coordinate system used is given in the figure below.

The task is to determine the total risk of collision with obstacles, the risk for a proposed OCH value of 30 m and the minimum acceptable OCH values in the specified conditions, for Category C and D aeroplanes.

Example 1 layout



# COLLISION RISK MODEL REQUEST FORM

(Revision 2)



ICAO identification  
(for ICAO use only)

4       6       8       10       12       14       16       18       20       22       24       26       28       30       32       34       36

## ADMINISTRATIVE DATA

- |           |                   |    |  |
|-----------|-------------------|----|--|
| <b>01</b> | ICAO reference    | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>  |
| <b>02</b> | User reference    | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><i>FANTASY AERODROME</i>                        |
| <b>03</b> | Request title     | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><i>CRM MANUAL DOC 9234-AN904 PART I APP D/E</i> |
| <b>04</b> | Requestor         | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><i>EXAMPLE I</i>                                |
| <b>05</b> | Address           | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><i>DEPARTMENT OF AVIATION FANTASYLAND</i>       |
| <b>06</b> | Person to contact | 4  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><b>Name</b> <i>MR JOHN OBSTACLE</i>             |
|           |                   | 24 | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><b>Telephone</b> <i>111-222-334</i>             |
|           |                   | 44 | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/><br><b>Telex</b> <i>44-5555</i>                     |

Boxes which must be filled in to operate the model are shaded thusly: ■

## GROUND DATA

- 1      **07** ILS glide path angle      4       .       degrees
- 1      **08** ILS reference datum height      4       .       M/F
- 1      **09** Distance between ILS localizer antenna and runway threshold      4       .       M/F
- 1      **10** Localizer course width at threshold      4       .       M/F
- 1      **11** Threshold elevation      4       .       M/F
- 1      **12** Distance from final approach point to threshold      4       .       M/F
- 1      **13** Standard termination of precision segment  
If No then:  
a) Termination point before threshold      4       Y/N  
b) Specify distance from termination point to threshold      6       .       M/F  
8       .  .  .  
13       .  .
- 1      **14** Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna      4       .       Y/N  
b) Wing semispan      9       .       M/F  
11       .  .  
15       .  .  
6       .  .  
13       .  .  
4       .  per cent

## AEROPLANE DATA

M = Metres, F = Feet, Y = Yes, N = No

## REQUESTED CASES

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- 16** ILS approach category  
1 Category I  
2 Category II  
3 Category I (radio altimeter only)  
4 Category II (autopilot only)

- 17** Select choice of OCA or OCH  
1 OCA (above mean sea level)  
2 OCH (above threshold)

**18** Specify unit of measurement for OCA/H

**19** Speed category      Risk for specified OCA/H requested?  
If Yes then OCA/H requested?

A	<input checked="" type="checkbox"/>	Y/N	6 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	12 <input checked="" type="checkbox"/>	Y/N
B	<input checked="" type="checkbox"/>	Y/N	66 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	22 <input checked="" type="checkbox"/>	Y/N
C	<input checked="" type="checkbox"/>	Y/N	26 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	32 <input checked="" type="checkbox"/>	Y/N
D	<input checked="" type="checkbox"/>	Y/N	36 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	42 <input checked="" type="checkbox"/>	Y/N

Note: A maximum of six (6) multiple pages of this requested cases form may be used as necessary to include additional cases. Each page will cause a complete report to be generated.

## REPORT FORMAT

- [20] Language  
1 English  
2 French  
3 Russian  
4 Spanish

- [21] Total number of obstacles to be processed  
 1/2/3/4

- [22] Individual obstacle risk requested for  
1 Obstacle with highest individual risk  
2 Obstacles with individual risk higher than  $1.0 \times 10^{-10}$   
3 All obstacles

## OBSTACLE COORDINATE SYSTEM SPECIFICATIONS

- [23] Runway coordinate system used  
If Yes then specify:  
a) Unit of horizontal measurement  
b) Unit of vertical measurement  
c) Height of threshold measured from this system reference  
 10  0
- [24] Grid coordinate system used  
If Yes then specify:  
a) Unit of horizontal measurement  
b) Unit of vertical measurement  
c) First coordinate of threshold  
d) Second coordinate of threshold  
e) Height of threshold measured from this system reference  
f) First coordinate of LLZ antenna  
g) Second coordinate of LLZ antenna  
 10   
 19   
 28   
 34   
 43

Page 5

- 25** Polar coordinate system used  
If Yes then specify:

a) Unit of distance measurement

Y/N

M/F

b) Unit of vertical measurement

M/F

c) Bearing to threshold

degrees

10     
16

d) Distance to threshold

degrees

24     
30      
36

e) Height of threshold measured from this system reference

Y/N

f) Bearing to LLZ antenna

Y/N

g) Distance to LLZ antenna

Y/N

- 26** Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

M/F

b) Latitude of threshold

degrees

8    
21

c) Longitude of threshold

degrees

10    
23

d) Height of threshold measured from this system reference

M/F

13    
16

seconds

e) Latitude of LLZ antenna

minutes

46    
54

seconds

f) Longitude of LLZ antenna

minutes

60    
56

seconds

N = North, S = South, E = East, W = West

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Page \_\_\_\_ of \_\_\_\_

Polar coordinate system

IDENT	DESCRIPTION
13	<i>NOT APPLICABLE</i>
32	
42	
57	
63	
P	

29

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9 of \_\_\_\_\_

**Geographical coordinate system****IDENT / DESCRIPTION**

N/S degrees      minutes      seconds

E/W degrees      minutes      seconds

P      45      minutes

Z      43      seconds

57      40

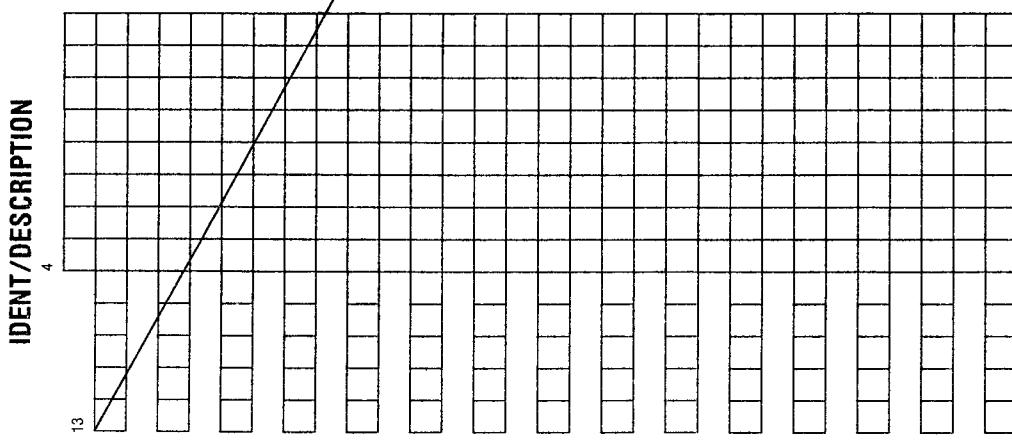
38      33

31      30

27      29

13      14

4

**30***NOT APPROXIMATE*

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.

## EXAMPLE 2 CAT II RUNWAY — OCH VALUES MORE THAN 30 M

### Introduction

In this example, an approach to a precision approach runway serviced by CAT II ILS is examined. The runway threshold is at the mean sea level (MSL).

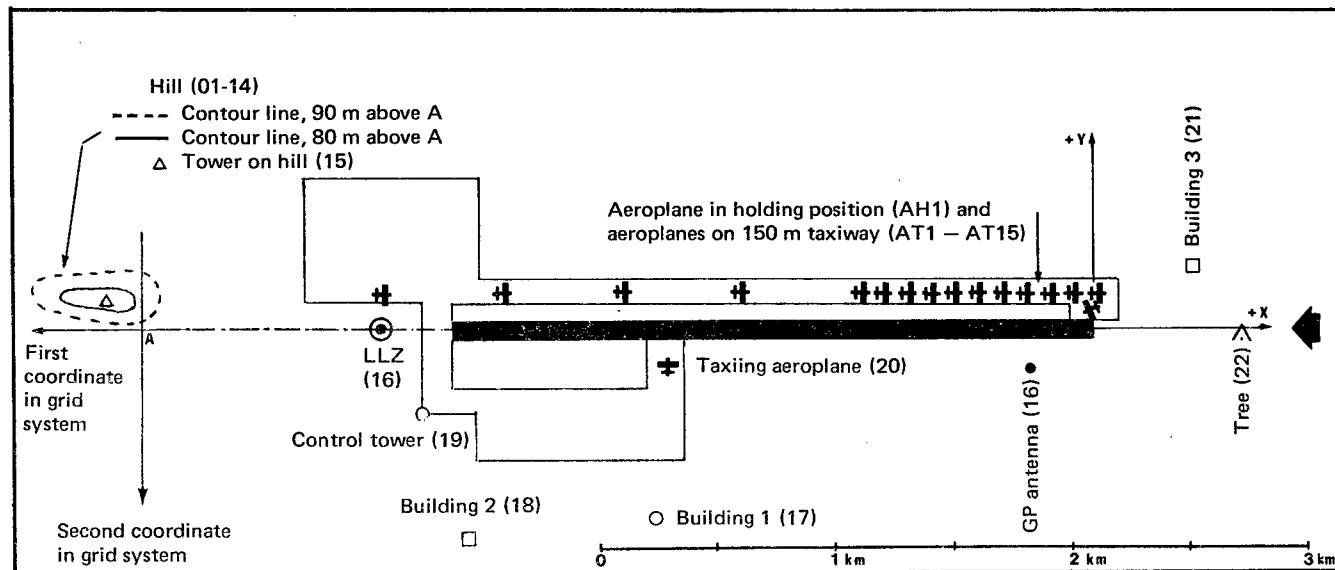
The ILS ground equipment is so installed that the ILS reference datum height and the localizer course width at threshold are standard and that the glide path angle is 3.00°. Distance between the ILS localizer antenna and the threshold is 3 000 m and the final approach point (FAP) is 10 807 m before the threshold and no obstacles are situated beyond this point.

The procedure is to be designed for aeroplanes up to standard dimensions, equipped with a flight director and being able to obtain at least the standard missed approach climb gradient.

The obstacle environment consists of nine obstacles, one of which is a hill modelled by 14 wall type obstacles. For description of the hill and wall coordinates see Appendix A, Figure 1-A-6. One aeroplane is assumed to be on a holding bay 120 m from the runway centre line and 15 aeroplanes are located on a taxiway 150 m from the runway centre line. The tail height of all aeroplanes is 22 m. For details, see the CRM Request Form (Item 27 for obstacles in the runway coordinate system and Item 28 for obstacles in the grid coordinate system). A representation of the layout together with the coordinate systems used is given in the figure below.

The task is to determine the total risk of collision with obstacles and the minimum acceptable OCH values in the specified conditions for all categories of aeroplanes.

**Example 2 layout**





# COLLISION RISK MODEL REQUEST FORM

(Revision 2)

**ICAO identification  
(for ICAO use only)**

 4

 6

 15

 24

 33

## ADMINISTRATIVE DATA

**01** ICAO reference

 4

**02** User reference

 4

**03** Request title

 4

**04** Requestor

 4

**05** Address

 4

**06** Person to contact

**Name**

 4

**Telephone**

 24

**Telex**

 44

Boxes which must be filled in to operate the model are shaded thusly: ■

## GROUND DATA

- 07 ILS glide path angle      4      5.  6.  7.  degrees
- 08 ILS reference datum height      4       5.  6.  7.  M/F
- 09 Distance between ILS localizer antenna and runway threshold      4       5.  6.  7.  M/F
- 10 Localizer course width at threshold      4       5.  6.  7.  M/F
- 11 Threshold elevation      4       5.  6.  7.  M/F
- 12 Distance from final approach point to threshold      4       5.  6.  7.  M/F
- 13 Standard termination of precision segment  
If No then:  
a) Termination point before threshold  
b) Specify distance from termination point to threshold
- 14 Standard dimensions  
If No then specify:  
a) Distance between the flight paths  
of the wheels and the GP antenna  
b) Wing semispan
- 15 Standard missed approach climb gradient  
If No then specify climb gradient

## AEROPLANE DATA

- 16  Y/N  
 M/F
- 17  Y/N  
 M/F
- 18  Y/N  
 per cent

M = Metres, F = Feet, Y = Yes, N = No

## REQUESTED CASES

1/2/83  
No. 1

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- [16] ILS approach category**
- 1 Category I
  - 2 Category II
  - 3 Category I (radio altimeter only)
  - 4 Category II (autopilot only)

- [17] Select choice of OCA or OCH**
- 1 OCA (above mean sea level)
  - 2 OCH (above threshold)

- [18] Specify unit of measurement for OCA/H**

- [19] Speed category**      **Risk for specified OCA/H requested?**      **Minimum acceptable OCA/H requested?**
- |   |   |  |
|---|---|--|
| <p>A      <input checked="" type="checkbox"/> Y/N</p> | <p>6      <input type="checkbox"/><br/><input type="checkbox"/><br/><input type="checkbox"/></p>  | <p>12      <input checked="" type="checkbox"/> Y/N</p> |
| <p>B      <input checked="" type="checkbox"/> Y/N</p> | <p>14      <input type="checkbox"/><br/><input type="checkbox"/><br/><input type="checkbox"/></p> | <p>22      <input checked="" type="checkbox"/> Y/N</p> |
| <p>C      <input checked="" type="checkbox"/> Y/N</p> | <p>24      <input type="checkbox"/><br/><input type="checkbox"/><br/><input type="checkbox"/></p> | <p>32      <input checked="" type="checkbox"/> Y/N</p> |
| <p>D      <input checked="" type="checkbox"/> Y/N</p> | <p>34      <input type="checkbox"/><br/><input type="checkbox"/><br/><input type="checkbox"/></p> | <p>42      <input checked="" type="checkbox"/> Y/N</p> |

Note: A maximum of six (6) multiple pages of this requested cases form may be used as necessary to include additional cases. Each page will cause a complete report to be generated.

## REPORT FORMAT

**[20]**

- Language  
1 English  
2 French  
3 Russian  
4 Spanish

**[21]** **1/2/3/4**

**[21]** Total number of obstacles to be processed

**[21]** **38**

**[22]** Individual obstacle risk requested for  
1 Obstacle with highest individual risk  
2 Obstacles with individual risk higher than  $1.0 \times 10^{-10}$   
3 All obstacles

**[22]** **1/2/3**

## OBSTACLE COORDINATE SYSTEM SPECIFICATIONS

**[23]**

Runway coordinate system used  
If Yes then specify:

a) Unit of horizontal measurement

b) Unit of vertical measurement

c) Height of threshold measured from this system reference

**[24]**

Grid coordinate system used  
If Yes then specify:

a) Unit of horizontal measurement

b) Unit of vertical measurement

c) First coordinate of threshold

d) Second coordinate of threshold

e) Height of threshold measured from this system reference

f) First coordinate of LLZ antenna

g) Second coordinate of LLZ antenna

**25** Polar coordinate system used  
If Yes then specify:

a) Unit of distance measurement

b) Unit of vertical measurement

c) Bearing to threshold

d) Distance to threshold

e) Height of threshold measured from this system reference

f) Bearing to LLZ antenna

g) Distance to LLZ antenna

4  Y/N

6  M/F

8  M/F

degrees

10  .

16  .

degrees

24  .

30  .

4  Y/N

6  M/F

8  M/F

10  minutes  .

16  minutes  .

27  minutes  .

30  minutes  .

35  minutes  .

36  minutes  .

40  minutes  .

45  minutes  .

50  minutes  .

55  minutes  .

60  minutes  .

63  minutes  .

N = North, S = South, E = East, W = West

**26** Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

b) Latitude of threshold

c) Longitude of threshold

d) Height of threshold measured from this system reference

e) Latitude of LLZ antenna

f) Longitude of LLZ antenna

Page 8  
Page \_\_\_\_ of \_\_\_\_

Polar coordinate system

IDENT	DESCRIPTION	BEARING	DISTANCE	Z	P
13				57	63
32		• .		42	
4					

E

NOT APPLICABLE

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9  
of \_\_\_\_\_

**Geographical coordinate system**

**IDENT/DESCRIPTION**

13	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
----	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

N/S degrees

minutes

seconds

E/W degrees

minutes

seconds

NOT APPLICABLE

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.

1  
30

### EXAMPLE 3 CAT I RUNWAY — OCH VALUE LESS THAN 60 M

#### Introduction

In this example, an approach to a precision approach runway serviced by CAT I ILS is examined. The runway threshold is at the mean sea level (MSL).

The ILS ground equipment is so installed that the ILS reference datum height is 18 m, the localizer course width at threshold is standard and the glide path angle is  $3.00^\circ$ . Distance between the ILS localizer antenna and the threshold is 3 000 m and the final approach point (FAP) is 10 807 m before the threshold and no obstacles are situated beyond this point.

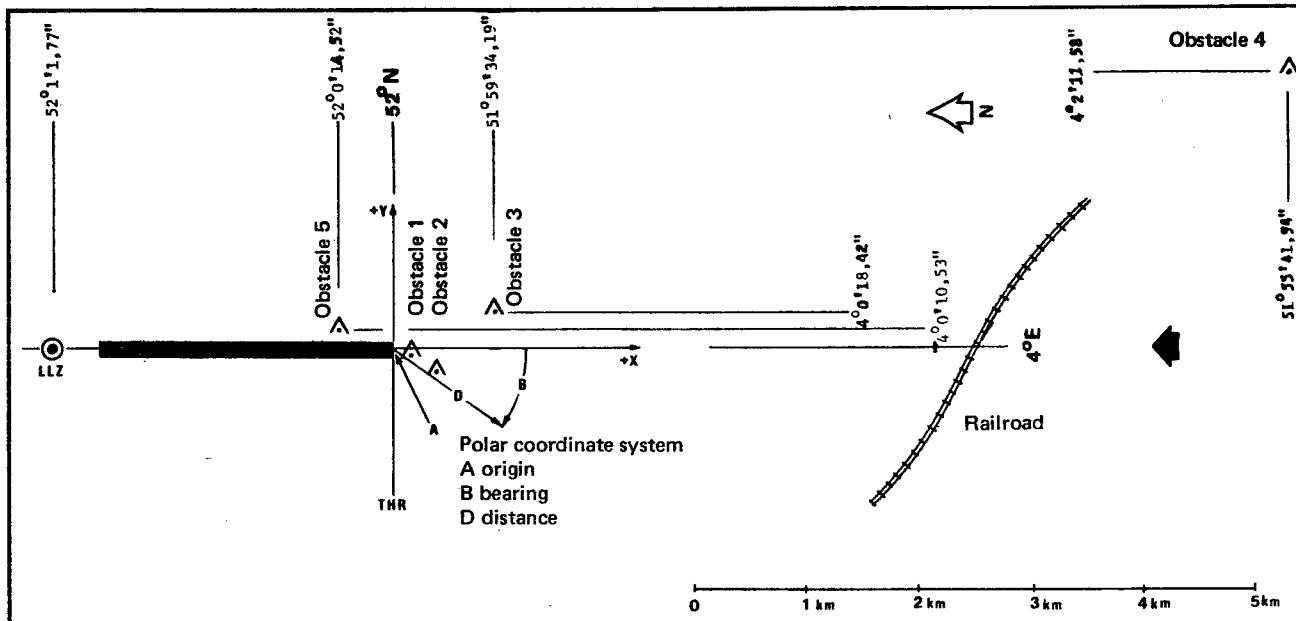
The procedure is to be designed for aeroplanes up to standard dimensions, equipped with pressure altimeters and being able to obtain at least the standard missed approach climb gradient.

The obstacle environment consists of five poles (Obstacles 1 to 5), and a railroad (Obstacles 6 to 10). For description see Appendix A, Figure 1-A-5. Obstacles 1 and 2 are given in the polar coordinate system and other obstacles in the geographical coordinate system. For details, see the CRM Request Form (Items 29 and 30). A representation of the layout together with the coordinate systems used is given in the figure below.

The task is to:

- determine the total risk of collision with obstacles, the risks for a proposed OCH value of 60 m and the minimum acceptable OCH values in the specified conditions, for all categories of aeroplanes; and
- to determine if in this obstacle environment an OCH value of 30 m would be acceptable in the specified conditions for category Cat C and D aeroplanes.

Example 3 layout





# COLLISION RISK MODEL REQUEST FORM

(Revision 2)

ICAO identification  
(for ICAO use only)

4      6      15      24      38  
               

## ADMINISTRATIVE DATA

<b>01</b>	ICAO reference	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>						
<b>02</b>	User reference	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>						
<b>03</b>	Request title	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>						
<b>04</b>	Requestor	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>						
<b>05</b>	Address	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>						
<b>06</b>	Person to contact	<table border="0"> <tr> <td>Name</td> <td>4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/></td> </tr> <tr> <td>Telephone</td> <td>24 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/></td> </tr> <tr> <td>Telex</td> <td>44 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/></td> </tr> </table>	Name	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	Telephone	24 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	Telex	44 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
Name	4 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>							
Telephone	24 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>							
Telex	44 <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>							

Boxes which must be filled in to operate the model are shaded thusly: ■

## GROUND DATA

- 07 ILS glide path angle      4  .  degrees
- 08 ILS reference datum height      4  .  M/F
- 09 Distance between ILS localizer antenna and runway threshold      4  .  M/F
- 10 Localizer course width at threshold      4  .  M/F
- 11 Threshold elevation      4  .  M/F
- 12 Distance from final approach point to threshold      4  .  M/F
- 13 Standard termination of precision segment  
If No then:  
a) Termination point before threshold  
b) Specify distance from termination point to threshold

## AEROPLANE DATA

- 14 Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna  
b) Wing semispan
- 15 Standard missed approach climb gradient  
If No then specify climb gradient

M = Metres, F = Feet, Y = Yes, N = No

## REQUESTED CASES

Page 1 of 2

Page 3 of 2

**16** ILS approach category  1/2/3/4  
1 Category I  
2 Category II  
3 Category I (radio altimeter only)  
4 Category II (autopilot only)

**17** Select choice of OCA or OCH  
1 OCA (above mean sea level)  
2 OCH (above threshold)

**18** Specify unit of measurement for OCA/H  M/F

**19** Speed category Risk for specified OCA/H requested?  
If Yes then OCA/H requested?

A	<input checked="" type="checkbox"/> Y/N	<input checked="" type="checkbox"/> Y/N
B	<input checked="" type="checkbox"/> Y/N	<input checked="" type="checkbox"/> Y/N
C	<input checked="" type="checkbox"/> Y/N	<input checked="" type="checkbox"/> Y/N
D	<input checked="" type="checkbox"/> Y/N	<input checked="" type="checkbox"/> Y/N

Note: A maximum of six (6) multiple pages of this requested cases form may be used as necessary to include additional cases. Each page will cause a complete report to be generated.

Page 5

**25**  Polar coordinate system used  
If Yes then specify:

a) Unit of distance measurement

b) Unit of vertical measurement

c) Bearing to threshold

d) Distance to threshold

e) Height of threshold measured from this system reference

f) Bearing to LLZ antenna

g) Distance to LLZ antenna

Y/N      M/F      M/F  
          
degrees      degrees      degrees  
10    .    00  
16       00  
24       00  
30       00  
36       00

**26**  Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

b) Latitude of threshold

c) Longitude of threshold

d) Height of threshold measured from this system reference

e) Latitude of LLZ antenna

f) Longitude of LLZ antenna

Y/N      M/F  
      
seconds      seconds  
10    minutes    00 .    00  
23     minutes    00 .    00  
27      minutes    00 .    00  
30       minutes    00 .    00  
35        minutes    00 .    00  
41         minutes    00 .    00  
43          minutes    00 .    00  
46           minutes    00 .    00  
49            minutes    00 .    00  
52             minutes    00 .    00  
56              minutes    00 .    00  
59               minutes    00 .    00  
63               minutes    00 .    00

N = North, S = South, E = East, W = West

**OBSTACLE DATA FILE**

Runway coordinate system

**IDENT****DESCRIPTION**

Z

Y2

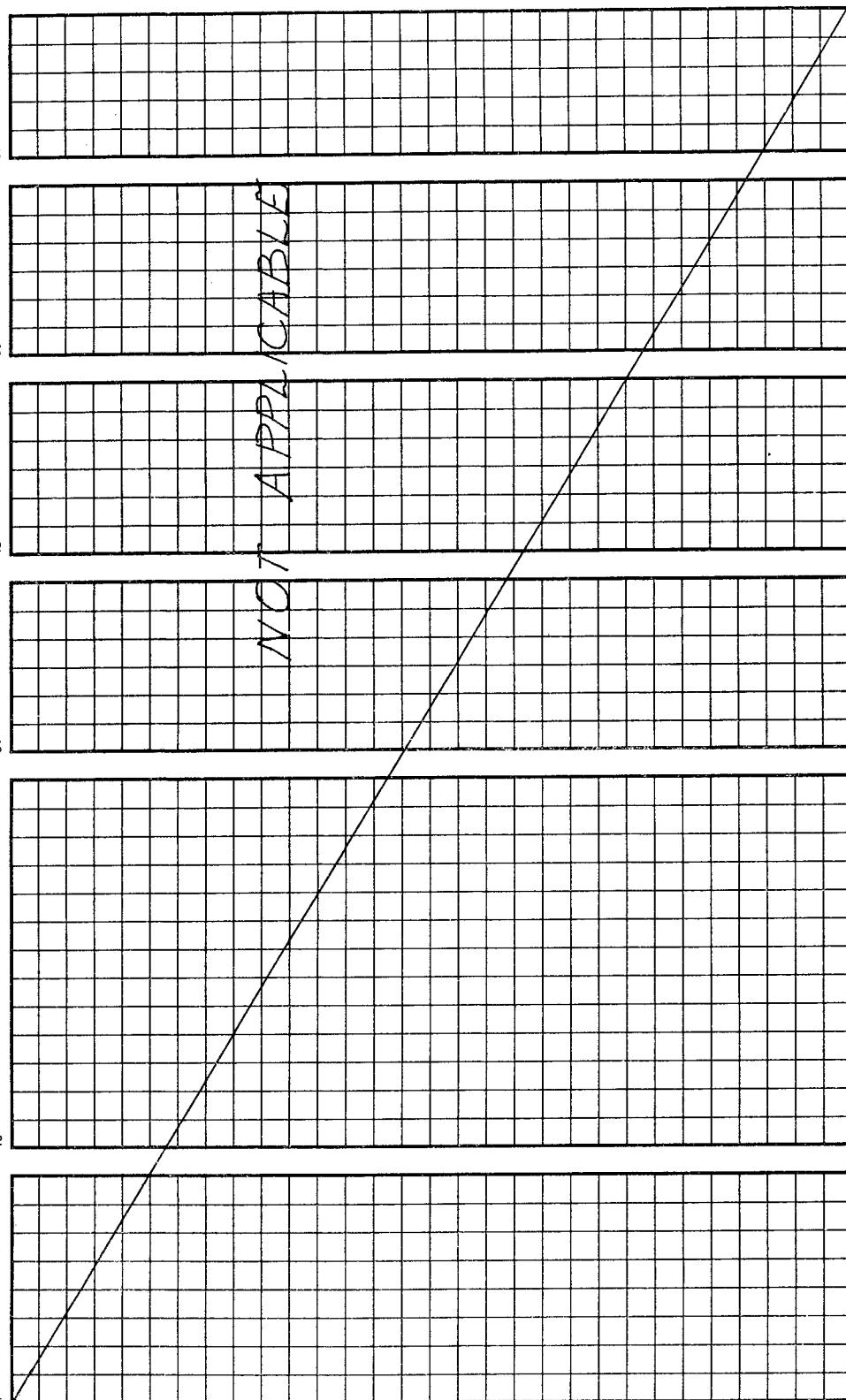
Y1

X

13

4

27

Page 6  
of \_\_\_\_\_

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9  
 Page 2 of 2

**Geographical coordinate system**

**IDENT/DESCRIPTION**

4	N/S degrees	minutes	33	seconds	E/W degrees		minutes	45	seconds	57	Z	P
					38	40	43	48	50	53		
13	0 BS 3	31	59	34	.19	E	0	18	.42			
POL E	0 BS 4	51	55	41	.94	E	2	11	.58			
POL E	0 BS 5	52	00	14	.52	E	0	10	.53			
POL E	0 BS 6	51	57	08	.78	E	4	00	04	21		
RA/LR R0 A D	0 BS 6	51	57	08	.78	E	4	00	07	37		
RA/LR R0 A D	0 BS 7	51	57	11	.37	E	4	00	02	10		
RA/LR R0 A D	0 BS 7	51	57	11	.37	E	4	00	04	21		
RA/LR R0 A D	0 BS 8	51	57	12	.67	E	3	59	58	95		
RA/LR R0 A D	0 BS 8	51	57	12	.67	E	4	00	02	10		
RA/LR R0 A D	0 BS 8	51	57	14	.29	E	3	59	59	74		
RA/LR R0 A D	0 BS 9	51	57	14	.29	E	3	59	58	95		
RA/LR R0 A D	0 BS 9	51	57	14	.29	E	3	59	59	74		
RA/LR R0 A D	0 BS 10	51	57	16	.07	E	3	59	59	74		
RA/LR R0 A D	0 BS 10	51	57	16	.07	E	3	59	53	76		

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.





## COLLISION RISK MODEL REQUEST FORM

(Revision 2)

ICAO identification  
(for ICAO use only)

4      6      15      24      33  
               

### ADMINISTRATIVE DATA

01 ICAO reference

4

02 User reference

4  
*FANTASY AERODROME*

03 Request title

4  
*CRM MANUAL DOC 9274 - ANG 904 PART I APP D/E*

4  
*EXAMPLE 4*

4  
*DEPARTMENT OF AVIATION FANTASYLAND*

4  
*HILL ROAD 35*

4  
*BIG CITY BOX 999*

4  
*FANTASYLAND*

4

4

4

4

4  
*44-5555*

06 Person to contact

Name

4  
*JR JOHN OBSTACLE*

Telephone

4  
*111-222-334*

Telex

4  
*44-5555*

Boxes which must be filled in to operate the model are shaded thusly: ■

## GROUND DATA

- 07** ILS glide path angle       3 .  00      degrees  
**08** ILS reference datum height       100 .  0      M/F  
**09** Distance between ILS localizer antenna and runway threshold       320 .  
**10** Localizer course width at threshold       200 .      M/F  
**11** Threshold elevation       150 .      M/F  
**12** Distance from final approach point to threshold       320 .      M/F  
**13** Standard termination of precision segment  
If No then:  
a) Termination point before threshold  
b) Specify distance from termination point to threshold       Y/N  
**14** Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna  
b) Wing semispan       Y/N  
**15** Standard missed approach climb gradient  
If No then specify climb gradient       6 .  0 per cent

## AEROPLANE DATA

- 16**  Y/N  
**17** Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna  
b) Wing semispan       Y/N  
**18** Standard missed approach climb gradient  
If No then specify climb gradient       6 .  0 per cent
- 
- M = Metres, F = Feet, Y = Yes, N = No

**25**  Polar coordinate system used  
If Yes then specify:

a) Unit of distance measurement

b) Unit of vertical measurement

c) Bearing to threshold

d) Distance to threshold

e) Height of threshold measured from this system reference

f) Bearing to LLZ antenna

g) Distance to LLZ antenna

4  Y/N

6  M/F

8  M/F

10  235 • 13 degrees

16  1749.

24  0.

30  218 • 21 degrees

36  4242.

**26**  Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

8  N/S 10  degrees 13  minutes 16  seconds

21  E/W 23  degrees 27  minutes 30  seconds

35  35  minutes 35  seconds

41  N/S 43  degrees 46  minutes 49  seconds

54  E/W 56  degrees 60  minutes 63  seconds

e) Latitude of LLZ antenna

N = North, S = South, E = East, W = West

**OBSTACLE DATA FILE**  
**Runway coordinate system**

**27**

**IDENT**

**4**

**DESCRIPTION**

**13**

A5 - 0 1	H/L/L	3 8 0	-1 0 5	-2 5 0	/ 5
A5 - 0 2	H/L/L	2 8 0	-8 0	-1 9	/ 5
A5 - 0 3	H/L/L	2 8 0	-2 4 7	-1 9	/ 5
A5 - 0 4	H/L/L	2 8 0	-2 4 7	-2 4 7	/ 5
A5 - 0 5	H/L/L	1 8 0	-6 0	-8 5	/ 5
A5 - 0 6	H/L/L	1 8 0	-8 5	-2 4 5	2 5
A6 - 0 1	H/L/L	1 8 0	-2 4 5	-2 4 5	/ 5
A6 - 0 2	H/L/L	1 8 0	-6 0	-8 5	/ 5
A6 - 0 3	H/L/L	1 8 0	-8 5	-2 4 0	2 5
A6 - 0 4	H/L/L	1 8 0	-2 4 0	-2 4 3	/ 5
A6 - 0 5	H/L/L	1 8 0	-8 5	-8 5	/ 5
A6 - 0 6	H/L/L	1 8 0	-2 4 0	-2 4 0	2 5
A6 - 0 7	H/L/L	1 8 0	-8 5	-2 4 0	/ 5
A6 - 0 8	H/L/L	1 8 0	-2 4 0	-2 4 0	2 5
A6 - 0 9	H/L/L	1 8 0	-8 5	-2 4 0	/ 5
A6 - 1 0	H/L/L	1 8 0	-2 4 0	-2 4 0	2 5
A6 - 1 1	H/L/L	6 0	-6 2	-1 0 0	/ 5
A6 - 1 2	H/L/L	6 0	-1 0 0	-2 6 0	2 5
A6 - 1 3	H/L/L	6 0	-2 6 0	-2 7 1	/ 5
A6 - 1 4	H/L/L	-2 0	-7 0	-2 6 8	/ 5
A6 - 1 5	TOWER	1 4 0	-1 3 0	-1 3 0	4 0

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 8 / of /

Polar coordinate system

IDENT	DESCRIPTION	DISTANCE	BEARING	Z	P
A8-02	L12 ANTENNA	42	4242	17	
A8-03	TOWER	42	4424	40	
A8-04	MASJ	42	5894	25	
		32			
		32			
		57			
		63			

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9 of \_\_\_\_\_

**Geographical coordinate system****IDENT/DESCRIPTION**

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

**30**

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.

#### **EXAMPLE 5 TELEX REQUEST**

This example has been developed to show how the attached CRM request can be transmitted by telex. A copy of the corresponding telex is included. It is suggested that a copy of this example and the corresponding telex be given to the telex operator together with the following instructions when a CRM request is made by telex:

1. On the first line of the telex type "CRM request to ICAO — Attention OPS/AIR Section".
2. Only information corresponding to that circled in the example need be transmitted.
3. Each line in the CRM Request Form where there is an entry should form a separate line on telex (although it may contain only one or two letters or numbers).
4. At least three spaces should be left blank between groups of characters (i.e., group of numbers, symbols M, F, Y, A, B, C, N, E, etc.) although in the form they usually are separated by a larger number of spaces.
5. In cases where space is provided for decimals, the decimal point must be typed and if the decimals are not entered on the form, zeros must be typed.
6. In case of a typing error, five E letters should be typed (EEEEEE) and the whole line repeated at the end of the telex (see the attached telex example).

Requests for changes to the original CRM request can also be submitted by telex. In this case, only the revisions, deletions and additions need be transmitted. However, it is imperative that a short narrative description be included in the telex to describe the nature of the changes (see Part I, 3.4.1).

Information circled in this sample form should be typed on the telex request.  
The corresponding telex is attached (see pages I-D-57 to I-D-59).

## COLLISION RISK MODEL REQUEST FORM (Revision 2)



**ICAO identification  
(for ICAO use only)**

### ADMINISTRATIVE DATA

<b>01</b> <b>ICAO reference</b> <input type="checkbox"/> 6 <input type="checkbox"/> 15 <input type="checkbox"/> 24 <input type="checkbox"/> 33	<b>02</b> <b>User reference</b> <input type="checkbox"/> FANTASY AERODROME	<b>03</b> <b>Request title</b> <input type="checkbox"/> CRM MANAG DOCUMENT 9274-AM904 PARTI APP DUE	<b>04</b> <b>Requestor</b> <input type="checkbox"/> DEPARTMENT OF AVIATION FANTASYLAND	<b>05</b> <b>Address</b> <input type="checkbox"/> HILL ROAD 35	<b>06</b> <b>Person to contact</b> <b>Name</b> <input type="checkbox"/> MARY JOHN STACKE
<b>01</b> <b>ICAO reference</b> <input type="checkbox"/> FANTASY AERODROME	<b>02</b> <b>User reference</b> <input type="checkbox"/> EXAMPLE ST TELEX REQUEST	<b>03</b> <b>Request title</b> <input type="checkbox"/> EXAMPLE ST TELEX REQUEST	<b>04</b> <b>Requestor</b> <input type="checkbox"/> DEPARTMENT OF AVIATION FANTASYLAND	<b>05</b> <b>Address</b> <input type="checkbox"/> BGC17Y BOX 999	<b>06</b> <b>Person to contact</b> <b>Telephone</b> <input type="checkbox"/> 111-222-3334
<b>01</b> <b>ICAO reference</b> <input type="checkbox"/> FANTASY AERODROME	<b>02</b> <b>User reference</b> <input type="checkbox"/> FANTASYLAND	<b>03</b> <b>Request title</b> <input type="checkbox"/> FANTASYLAND	<b>04</b> <b>Requestor</b> <input type="checkbox"/> FANTASYLAND	<b>05</b> <b>Address</b> <input type="checkbox"/> 44-5555	<b>06</b> <b>Person to contact</b> <b>Telex</b> <input type="checkbox"/> 44-5555

Boxes which must be filled in to operate the model are shaded thusly: ☐

## GROUND DATA

- 07 ILS glide path angle  60 degrees   
08 ILS reference datum height  M/F   
09 Distance between ILS localizer antenna and runway threshold  3000'  M/F   
10 Localizer course width at threshold  3'  M/F   
11 Threshold elevation  10'  M/F   
12 Distance from final approach point to threshold  1000'  M/F   
13 Standard termination of precision segment  
If No then:  
a) Termination point before threshold  Y/N   
b) Specify distance from termination point to threshold  13'  M/F   
  

## AEROPLANE DATA

  
14 Standard dimensions  
If No then specify:  
a) Distance between the flight paths of the wheels and the GP antenna  6'  M/F   
b) Wing semispan  11'  M/F   
  
15 Standard missed approach climb gradient  
If No then specify climb gradient  6'  per cent  Y/N

M = Metres, F = Feet, Y = Yes, N = No

**REQUESTED CASES**1/2/83  
No. 1Page 3  
Page Z of Z 1/2/3/4 1/2 ILS approach category 1 Category I 2 Category II 3 Category I (radio altimeter only) 4 Category II (autopilot only) Select choice of OCA or OCH 1 OCA (above mean sea level) 2 OCH (above threshold) 1/2 Specify unit of measurement for OCA/H M/F Speed category      Risk for specified OCA/H requested?  
If Yes then OCA/HMinimum acceptable  
OCA/H requested? Y/N Y/N Y/N Y/N Y/N Y/N6       61066       61026       61036       610 Y/N Y/N Y/N Y/N Y/N A B C D

Note: A maximum of six (6) multiple pages of this requested cases form may be used as necessary to include additional cases. Each page will cause a complete report to be generated.

**REPORT FORMAT**

20

- Language  
1 English  
2 French  
3 Russian  
4 Spanish

1/2/3/4

21 Total number of obstacles to be processed

1/6

- 22 Individual obstacle risk requested for  
1 Obstacle with highest individual risk  
2 Obstacles with individual risk higher than  $1.0 \times 10^{-10}$   
3 All obstacles

1/2/3

**OBSTACLE COORDINATE SYSTEM SPECIFICATIONS**

23

- Runway coordinate system used  
If Yes then specify:  
a) Unit of horizontal measurement  
b) Unit of vertical measurement

Y/N

M/F

M/F

M/F

10  
  □ □ □ □ - 4

Y/N

M/F

M/F

19  
  □ □ □ □ - 30

Y/N

M/F

M/F

34  
  □ □ □ □ - 1000

43  
  □ □ □ □ - 0

24

- Grid coordinate system used  
If Yes then specify:  
a) Unit of horizontal measurement  
b) Unit of vertical measurement  
c) Height of threshold measured from this system reference

Y/N

M/F

M/F

10  
  □ □ □ □ - 4000

Y/N

M/F

M/F

19  
  □ □ □ □ - 30

Y/N

M/F

M/F

34  
  □ □ □ □ - 1000

43  
  □ □ □ □ - 0

- g) Second coordinate of LLZ antenna

**25** Polar coordinate system used  
If Yes then specify:

a) Unit of distance measurement

b) Unit of vertical measurement

c) Bearing to threshold

d) Distance to threshold

e) Height of threshold measured from this system reference

f) Bearing to LLZ antenna

g) Distance to LLZ antenna

<input checked="" type="checkbox"/>	Y/N
<input type="radio"/>	M/F
<input type="radio"/>	M/F

degrees

10  
2 3 5 . 1 3  
16  
[ ] / 7 4 9 .  
24  
[ ] [ ] [ ] 0 .

degrees

10  
2 7 8 . 2 1  
36  
[ ] [ ] 4 2 4 2 .  
36

**26** Geographical coordinate system used  
If Yes then specify:

a) Unit of vertical measurement

b) Latitude of threshold

c) Longitude of threshold

10  
N/S  
13  
5 2  
23  
[ ] 4  
35  
[ ] [ ] [ ] 0 .

10  
E/W  
23  
0 0  
35  
[ ] [ ] 0 .

13  
N/S  
46  
5 2  
56  
[ ] 7  
60  
[ ] [ ] 0 .

13  
E/W  
46  
3 6  
56  
[ ] [ ] 0 .

e) Latitude of LLZ antenna

f) Longitude of LLZ antenna

N = North, S = South, E = East, W = West

**OBSTACLE DATA FILE**

27 Runway coordinate system

**IDENT**

34	(GP - ANTENNAA)
35	(BU / LD / NG - 1)
36	(BU / LD / NG - 2)
37	(TOWER)
38	(TAXI / NG AEROA)
39	(BU / LD / NG - 3)
40	(TREED)

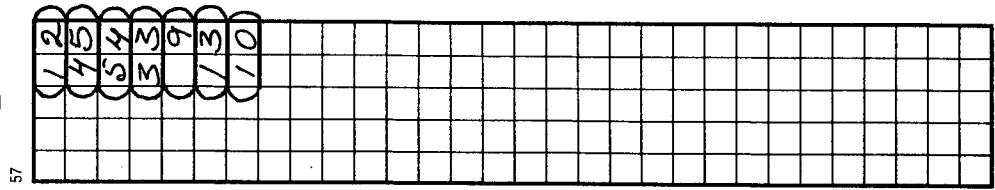
**DESCRIPTION**

13	(GP - ANTENNAA)
35	(BU / LD / NG - 1)
36	(BU / LD / NG - 2)
37	(TOWER)
38	(TAXI / NG AEROA)
39	(BU / LD / NG - 3)
40	(TREED)

Page 2 of 2

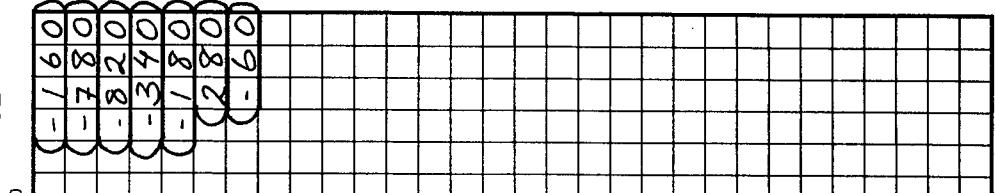
Z

57



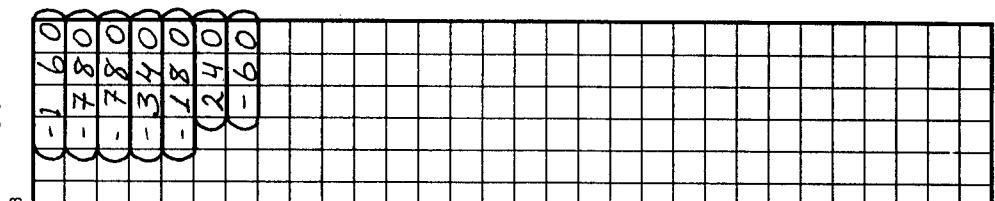
Y2

50



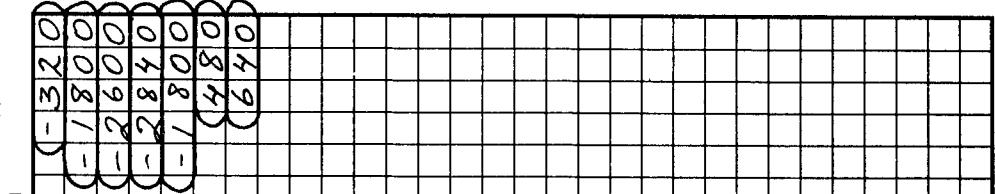
Y1

43



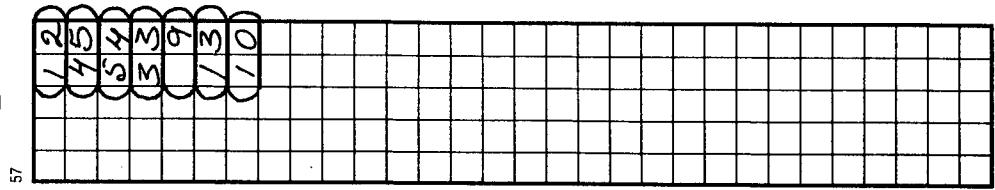
X

31



Z

57



Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

27

Page    of   **Grid coordinate system****28****IDENT**

/Y
/S
/G

**DESCRIPTION**

H/L/L
H/L/L
H/L/L

**FIRST**

/80
/80
/80

**SECOND**

-245
-245
-60

**Z**

90
80
80

**P**

63
----

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page    of

P	
Z	
DISTANCE	
BEARING	
DESCRIPTION	
IDENT	

63

57

42

32

13

4

**Note:** Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

Page 9 of 1**Geographical coordinate system****IDENT/DESCRIPTION**

13      **(P|O|L|E)**      (0|8|S|3)  
       **(P|O|L|E)**      (0|8|S|4)  
       **(P|O|L|E)**      (0|8|S|5)  
       **(P|O|L|E)**      (0|8|S|5)

4	minutes	33	seconds	33	seconds	40	minutes	43	seconds	45	seconds	57	z	P
27	<b>(W)</b>	<b>(5 7)</b>	<b>(3 3)</b>	<b>(7 9)</b>	<b>(5 9)</b>	<b>(7 9)</b>	<b>(5 7)</b>	<b>(2 1)</b>	<b>(1 8)</b>	<b>(4 2)</b>	<b>(1 5 0)</b>	<b>(1 4 0)</b>	<b>(5 8)</b>	<b>(1 5 0)</b>
28	<b>(W)</b>	<b>(5 7)</b>	<b>(5 7)</b>	<b>(4 7)</b>	<b>(5 7)</b>	<b>(4 7)</b>	<b>(5 7)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 3)</b>	<b>(8 1)</b>	<b>(1 0 5 3)</b>	<b>(1 0 5 3)</b>	<b>(8 1)</b>
29	<b>(W)</b>	<b>(5 2)</b>	<b>(6 2)</b>	<b>(6 2)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(6 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>
30	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
31	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
32	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
33	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
34	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
35	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
36	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
37	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
38	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
39	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
40	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
41	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
42	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
43	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
44	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
45	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
46	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
47	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
48	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
49	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
50	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
51	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
52	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
53	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
54	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
55	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
56	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
57	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
58	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
59	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
60	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
61	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
62	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					
63	<b>(W)</b>	<b>(5 2)</b>	<b>(1 0)</b>	<b>(1 0)</b>	<b>(5 2)</b>	<b>(5 2)</b>	<b>(1 0 5 2)</b>	<b>(1 0 5 2)</b>	<b>(5 2)</b>					

30

Note: Multiple pages of this obstacle data form may be used as necessary to include all obstacles.

N = North, S = South, E = East, W = West.

6.7.3 The height loss probability is calculated from the height loss distributions. It is the probability that an aeroplane would be below the obstacle height at the lowest point of its missed approach, and this distribution is hence independent of range. This distribution was used to obtain the height loss/altimeter margin table (Table 2-4) in the PANS-OPS, Volume II, Part III (Reference 2). The probability of sufficient height loss from the proposed OCH to be below the obstacle height is calculated from the height loss distribution table (Table II-4-23).

6.7.4 The climb out probability is based on the missed approach flight path distributions derived from the height loss model. The distribution mean is calculated from the final table value using the specified minimum climb gradient (nominally 2.5%). The distribution standard deviation is assumed to remain constant with the final table value. The normalized displacement of the obstacle is expressed in terms of the number of standard deviations from the mean. The Category I (pressure altimeter) missed approach distributions are defined by Gaussian distribution. The Category II (radio altimeter) missed approach distributions, however, are defined by Johnson SU distribution (Reference 26) and require a transformation before a Gaussian distribution probability table can be used. These transformations are defined by:

$$Z' = \text{Gamma} + \text{Delta} (\text{Sin } h^{-1} \left( \frac{Z - X_i}{\Lambda} \right))$$

Where:

- a) Gamma, Delta, Lambda and Xi are given in Table II-4-16 through II-4-27;
- b) Sin  $h^{-1}$  is the hyperbolic arc sine function; and
- c) is the normalized argument.

6.7.5 Where an obstacle in the approach lies below the specified OCH level, the approach probability derived as in 6.7.2 may considerably overestimate the risk, since it represents the proportion of the population who would have impacted the obstacle had they continued tracking below OCH. This is the subset of the population for whom the obstacle presents a potential hazard. However all such aeroplanes must have initiated a missed approach upon reaching OCH (if without adequate visual reference); and the proportion of this subset that will descend to the level of the obstacle during their missed approach is given by the height loss probability evaluated as in 6.7.3. Since the two probabilities are independent, the vertical risk associated with such an obstacle is the product of the two. This adjustment ensures that the approach vertical distributions reflect the fact that a missed approach will be initiated upon reaching OCH, whatever the range at which this level is reached.

6.7.5.1 Moreover with the height loss probability for an obstacle extending above OCH level being unity, the product

remains valid whatever the height of the obstacle in the approach.

6.7.5.2 A combined approach/height loss probability is therefore calculated as the product of the approach probability (see 6.7.2) and the height loss probability (see 6.7.3).

6.7.6 The combined approach/height loss probability (see 6.7.5), the height loss probability (see 6.7.3) and the climb-out probability (see 6.7.4) are compared, and the smallest probability applies at the given range.

## 6.8 CALCULATION OF LATERAL PROBABILITIES

6.8.1 The mean of the lateral distribution is equal to zero (the extended runway centre line) at all ranges.

6.8.2 The standard deviation of the lateral distribution at the range of the obstacle is established. The lateral standard deviations in the approach are calculated using linear interpolation or extrapolation from the probabilities from the nearest two ILS lateral distributions. These numbers are used until they become less than or equal to the standard deviations from the missed approach distributions, at which point the model assumes that a limiting value is reached. This constant value applies down to the range where the standard deviation of the missed approach table becomes applicable at 300 m (as adjusted for non-standard conditions in 6.6.3). Linear interpolation of the table values is then used until the end of the table at -1 200 m (as adjusted in 6.6.3). Linear extrapolation from the last two values is used for the remainder of the missed approach.

6.8.3 Given the mean and standard deviation, the displacement of the obstacle is expressed in terms of a number of standard deviations from the mean. This is done by subtracting the mean from the displacement and then dividing by the standard deviation.

6.8.4 The lateral probability is calculated using this displacement with the ILS localizer distribution shape. Before 7 800 m the 7 800 m distribution shape is used. Between 7 800 m and 1 200 m exponential interpolation is used between the probabilities from the nearest two ILS distributions. After 1 200 m the 1 200 m distribution shape is used.

## 6.9 CALCULATION OF INDIVIDUAL OBSTACLE RISK

6.9.1 After the individual probabilities are calculated, the individual obstacle risk is determined. The lateral risk is calculated as the probability that the lateral position of the aeroplane centre is between the two sides of the obstacle (as

modified by aeroplane wing semi-span; see Part I, Appendix A), and the vertical risk is calculated as the probability that the vertical position of the aeroplane centre is below the height of the obstacle (as modified by aeroplane wheel height (see Part I, Appendix A)). The individual obstacle risk is the product of the lateral risk and the vertical risk (see Chapter 2).

**6.9.2** This risk is the risk of collision with an individual obstacle for an aeroplane making an approach and subsequent missed approach. To obtain the predicted risk per approach, the individual risk is weighted by the missed approach factor. The calculation of this factor is explained in detail in Chapter 7. The factor is applied to both the height loss and missed approach climb-out probabilities, but not where obstacles below the glide path are already being factored by the approach probability (see 6.7.5), since the two factors are not independent.

**6.9.3** The individual risks, as adjusted by the missed approach factor, are then accumulated to obtain a total collision risk per approach. Prior to this accumulation however, risks for closely located individual obstacles are adjusted for "shadowing." This adjustment is explained in Chapter 8.

## 6.10 EXAMPLE OF CALCULATION OF RISKS

**6.10.1** The following sample calculations show the actual details of risk calculation used in the CRM. Risks are calculated for three obstacles — one in the approach, one in the missed approach, and one in the transition area between the two — on a single instrument approach. It is not intended that the model be applied manually in practice; these sample calculations are given to show how the model works. It should also be noted that these manual calculations are not carried out to the same precision as the computer model and therefore rounding errors could cause these numbers to differ slightly from those generated by the computer model.

**6.10.2** The sample calculations are based on the following input data. This is sample data only and does not necessarily represent any actual approaches.

### 6.10.2.1 Aerodrome and runway data.

- Runway threshold elevation: 400 m above mean sea level
- Glide path angle: 3.0°
- ILS reference datum height (RDH) at threshold: 15 m
- Distance from localizer to threshold: 2 000 m
- Localizer course width at threshold: 225 m

### 6.10.2.2 Approach data.

- Approach category: Category I
- Proposed obstacle clearance height (OCH): 75 m above runway threshold elevation (475 m above mean sea level)

### 6.10.2.3 Aeroplane data.

- Aeroplane speed category: B
- Aeroplane height from bottom of wheels to ILS glide path antenna: 4.5 m
- Aeroplane wing semi-span: 20 m
- Minimum required aeroplane climb gradient: 2.5 per cent

### 6.10.2.4 Obstacle data for approach obstacle.

- Range (x value): 6 500 m prior to runway threshold
- Height (z value): 230 m above runway threshold elevation (630 m above mean sea level)
- Lateral displacements from extended runway centre line (y values): from 320 to 340 m to the right of the centre line

### 6.10.2.5 Obstacle data for transition obstacle.

- Range (x value): 1 200 m prior to runway threshold
- Height (z value): 40 m above runway threshold elevation (440 m above mean sea level)
- Lateral displacements from extended runway centre line (y values): from 100 m to the left of the centre line to 150 m to the right of the centre line

### 6.10.2.6 Obstacle data for missed approach obstacle.

- Range (x value): 100 m prior to runway threshold
- Height (z value): 100 m above runway threshold elevation (500 m above mean sea level)
- Lateral displacements from extended runway centre line (y values): from 300 to 400 m to the left of the centre line

**6.10.3** The obstacle dimensions are adjusted to account for aeroplane dimensions and runway threshold elevation.

**6.10.3.1** The aeroplane height from bottom of wheels to ILS glide path antenna (4.5 m) is added to the obstacle height (see 6.2.1) to obtain z values of +234.5 m for the approach obstacle, 44.5 m for the transition obstacle, and +104.5 m for the missed approach obstacle.

**6.10.3.2** The aeroplane wing semi-span (20 m) is subtracted from the coordinate of the left side of the obstacle

Table II-6-5. Sample Adjusted Lateral Missed Approach Distributions

Distribution (metres)	Range (metres)	Mean (metres)	Standard Deviation (metres)
300	1 120.87	0	21.40
200	1 020.87	0	21.40
100	920.87	0	21.40
0	820.87	0	22.01
-100	720.87	0	22.64
-200	620.87	0	24.37
-300	520.87	0	26.45
-600	220.87	0	33.99
-900	-79.13	0	43.57
-1 200	-379.13	0	53.27

6.10.7.3 Standard deviation for the lateral approach distribution is calculated at the actual OCH range of 1 230.73 m by using linear extrapolation from the adjusted distributions in Table II-6-2. This gives a standard deviation of 21.40 m. The difference of 9.34 m between this value and the initial standard deviation of 12.06 m from the lateral missed approach distributions is then added to all the distribution standard deviations (see 6.6.4).

6.10.7.4 The adjusted lateral missed approach distributions are described in Table II-6-5.

6.10.8 After these adjustments are made, the risk for the first obstacle is calculated. The first obstacle in this approach is the approach obstacle with  $x$  equal to +6 500 m,  $z$  equal to +235.59 m,  $y_1$  equal to +300 m, and  $y_2$  equal to +360 m (see 6.10.3).

6.10.8.1 The approach vertical risk is calculated using Table II-6-3 (see 6.7.2).

6.10.8.1.1 The distribution mean at this range is equal to the glide path height. At 6 500 m prior to the threshold on a 3.0° glide path with a 15 m height at the threshold, this height is 355.65 m.

6.10.8.1.2 The distribution standard deviation at this range is calculated by linear interpolation between the Table II-6-3 values of 13.6 m at a range of 4 263.78 m and 27.4 m at a range of 7 863.78 m. At the obstacle range of 6 500 m, this gives an interpolated standard deviation of 22.17 m.

6.10.8.1.3 The adjusted obstacle height ( $z$ -value) of 235.59 m is expressed in terms of the number of standard deviations from the mean. This gives a displacement of 5.42 standard deviations below the mean.

6.10.8.1.4 The approach vertical probabilities are calculated for 5.42 standard distributions using the 4 200 m and 7 800 m distribution shapes from Table II-3-9. First exponential interpolation is used between the table values for 5.4 and 5.6 standard deviations to obtain a value for 5.42 standard deviations for each distribution. This gives probabilities of  $1.865 \times 10^{-5}$  (or 0.00001865) from the 4 200 m distribution and  $9.817 \times 10^{-6}$  (or 0.000009817) from the 7 800 m distribution.

6.10.8.1.5 The approach vertical risk is then calculated by exponential interpolation for the range of 6 500 m between the values of  $1.865 \times 10^{-5}$  for a range of 4 263.78 m and  $9.817 \times 10^{-6}$  for a range of 7 863.78 m. This gives an approach vertical risk for this obstacle (probability of the aeroplane being lower than the obstacle height at the obstacle range) of  $1.252 \times 10^{-5}$  (or 0.00001252).

6.10.8.2 Since the obstacle height is 160.59 m higher than the OCH of 75 m, the height loss probability is approximately equal to 1.

6.10.8.3 Since the obstacle range is 6 500 m prior to the threshold, the missed approach climb-out probability is approximately equal to 1.

6.10.8.4 The vertical risk for this obstacle is thus equal to the approach vertical risk of  $1.252 \times 10^{-5}$ .

6.10.8.5 The lateral risk is then calculated as follows using Table II-6-2.

1. The distribution mean is equal to 0 (the extended runway centre line) (see 6.8.1).
2. The distribution standard deviation at this range is calculated by linear interpolation between the Table II-6-2 values of 55.75 m at a range of 4 200 m and 114.27 m at a range of 7 800 m (see 6.8.2). At the obstacle range of

- 6 500 m, this gives an interpolated standard deviation of 93.14 m.
3. The adjusted lateral dimensions of the obstacle ( $y$  values) of 300 m and 360 m are expressed in terms of the number of standard deviations from the mean (see 6.8.3). This gives lateral displacements of 3.22 and 3.87 standard deviations from the mean.
  4. The lateral probabilities are calculated for 3.22 and 3.87 standard deviations using the 4 200 m and 7 800 m distribution shapes from Table II-3-7 (see 6.8.4). Exponential interpolation is used between the table values for 3.2 and 3.4 standard deviations to obtain probabilities for 3.22 standard deviations of  $3.259 \times 10^{-3}$  (or 0.003259) from the 4 200 m distribution and  $3.039 \times 10^{-3}$  (or 0.003039) from the 7 800 m distribution, and exponential interpolation is used between the table values for 3.8 and 4.0 standard deviations to obtain probabilities for 3.87 standard deviations of  $1.034 \times 10^{-3}$  (or 0.001034) from the 4 200 m distribution and  $7.528 \times 10^{-4}$  (or 0.0007528) from the 7 800 m distribution.
  5. The lateral probabilities for the two sides of the obstacle are then calculated by exponential interpolation between the 4 200 m distribution value and the 7 800 m distribution value (see 6.8.4). This gives lateral probabilities of  $3.117 \times 10^{-3}$  (or 0.003117) for the left side of the obstacle and  $8.442 \times 10^{-4}$  (or 0.0008442) for the right side of the obstacle.
  6. The lateral risk is then calculated by subtracting the probability of  $8.442 \times 10^{-4}$  for the right side of the obstacle from the probability of  $3.117 \times 10^{-3}$  for the left side of the obstacle (see 6.9.1). This gives a lateral risk for this obstacle (probability of the aeroplane being laterally displaced between the two sides of the obstacle) of  $2.273 \times 10^{-3}$  (or 0.002273).
  7. The individual obstacle risk is calculated as the product of the vertical risk of  $1.252 \times 10^{-5}$  and the lateral risk of  $2.273 \times 10^{-3}$  (see 6.9.1). This gives an individual obstacle risk of  $2.846 \times 10^{-8}$  (or 0.0000002846).
  8. This obstacle, at a range of 6 500 m prior to the runway threshold and 5 269.27 m prior to the OCH range, is always considered part of the approach, and its risk is not affected by the missed approach rate (see 6.9.2 and Chapter 7).
  9. There is no adjustment to the risk for this obstacle because of shadowing by other obstacles, since this obstacle is the first one reached on the approach (see 6.9.3 and Chapter 8).

6.10.9 After completing calculations for the first obstacle, each additional obstacle is considered in turn in order of decreasing range. The next obstacle in this sample approach is the transition obstacle with  $x$  equal to +1 200 m,  $z$  equal to 45.59 m,  $y_1$  equal to -120 m, and  $y_2$  equal to +170 m (see 6.10.3).

6.10.9.1 The approach vertical risk is calculated as follows using Table II-6-3 (see 6.7.2):

1. The distribution mean at this range is equal to the glide path height. At 1 200 m prior to the threshold on a 3.0° glide path with a 15 m height at the threshold, this height is 77.89 m.
2. The distribution standard deviation at this range is the limiting value of 5.8 m from Table II-6-3.
3. The adjusted obstacle height ( $z$  value) of 45.59 m is expressed in terms of the number of standard deviations from the mean. This gives a displacement of 5.57 standard deviations below the mean.
4. The approach vertical probability is calculated for 5.57 standard deviations using the 1 200 m distribution shape from Table II-3-9 as follows. This gives a probability of  $1.844 \times 10^{-5}$ .

6.10.9.2 The height loss vertical risk is calculated as follows using Table II-4-23 (see 6.7.3):

1. The amount of height loss required for an aeroplane with a wheel to antenna height of 4.5 m executing a missed approach at an OCH of 75 m to be below the obstacle height of 45.59 m is 33.91 m.
2. The probability of a height loss of 33.91 m (using Table II-4-23) is  $2.197 \times 10^{-3}$  (or 0.002197).

6.10.9.3 Since the obstacle range is 1 200 m prior to the threshold, the missed approach climb-out probability is approximately equal to 1.

6.10.9.4 The vertical risk for this obstacle is equal to the product of the approach risk of  $1.844 \times 10^{-5}$  and the height loss risk of  $2.197 \times 10^{-3}$ . The vertical risk is therefore  $4.051 \times 10^{-8}$ .

6.10.9.5 Since the obstacle extends for a considerable distance on both sides of the runway centre line, the lateral risk is approximately 1.

6.10.9.6 The individual obstacle risk is calculated as the product of the vertical risk of  $4.051 \times 10^{-8}$  and the lateral risk of 1.000. This gives an individual obstacle risk of  $4.051 \times 10^{-8}$ .

6.10.9.7 Since the approach risk is less than 0.01, a missed approach factor adjustment is not applicable (see 6.9.2).

6.10.9.8 There is no adjustment to the risk for this obstacle because of shadowing by other obstacles (see 6.9.3 and Chapter 8).

6.10.10 After completing calculations for the second obstacle, the third obstacle is then considered. The next